Role of IC in design and building of new hospitals

Dr Ling Moi Lin
Director, Infection Control
Singapore General Hospital

Change: model of care

- Acute care to personalized patient care, population care
- Ageing population, greater demand for nursing homes and community hospitals
- Attrition in skilled manpower

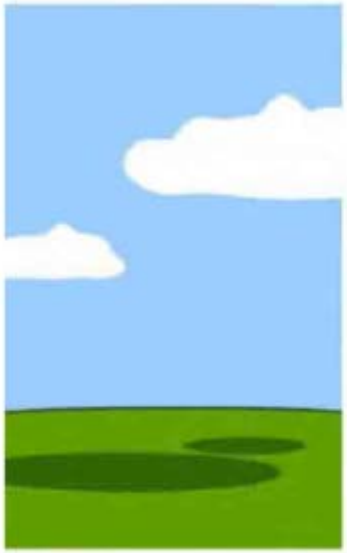
How the customer explained it

How the project leader understood it

How the analyst designed it

How the programmer wrote it

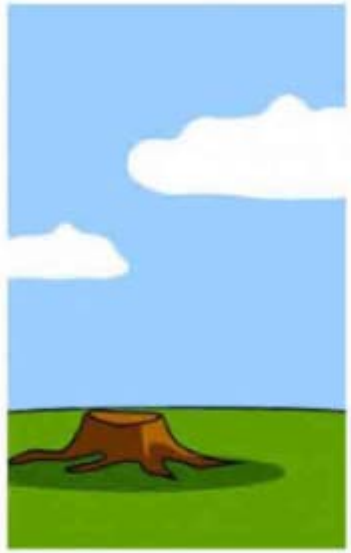
How the business consultant described it



How the project was documented

What operations installed

How the customer was billed



How it was supported

What the customer really needed

Healthcare facility planning

- Design for patient-centred care
  - Patient and family involvement in care
    - Open visitation but determined collaboratively between caregivers and family;
    - Single-bed rooms with space for families; and opportunity to participate in patient care rounds by clinical personnel.
- Acute vs community hospital design vs nursing home design

Healthcare facility planning

- Planning for future needs
  - Constant need for repair, remediation work (cabling, room additions), or replacement
  - These processes increase risks of environmental contamination, affecting air and water quality and sustainability
- Planning for surge capacity
  - Recent pandemics point to need for surge capacity planning for potential airborne infectious agent releases or a major influx of patients with communicable disease e.g. influenza pandemic

Planning stage

- Limit the risk of infection of the occupants, healthcare workers and building contractors, are met during the project
- Design features that will minimise the risk of transmission of infection
- Design issues considered at the project planning stage to avoid costly modification at a later stage

Design for safe and efficient environment

- Encourage desired behaviour e.g. hand hygiene
- Sufficient space
- Sufficient storage to discourage clutter
- Proper segregation and management of waste (clinical waste, linen)
- Bedside waste disposal facilities
- Suitable facilities for cleaning of equipment
- Good separation of clean and dirty activities

Planning phase: prevention and control of infection implications are not compromised by reducing or overcrowding in clinical areas

- storage and equipment cleaning areas
- ventilation
- hand hygiene facilities
- furnishing
- appropriate finishes
- isolation rooms/rooms used to segregate patients
- specific products with infectious implications
- applicable regulations

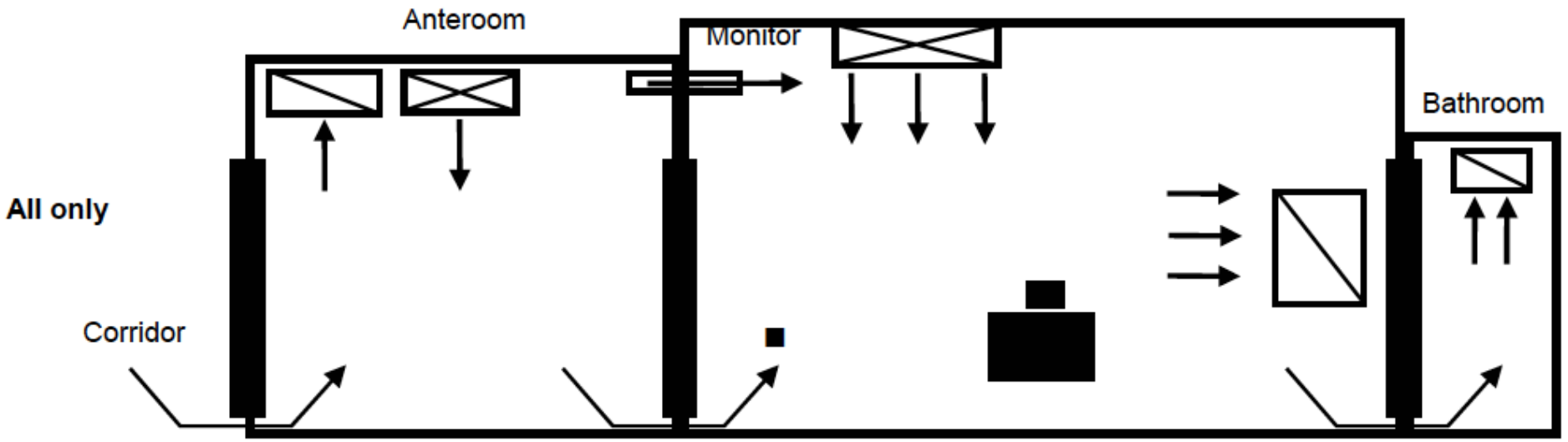
Is facility designed to support prevention and control of infection practice?

Design, number and type of isolation rooms (i.e. source or protective environment)

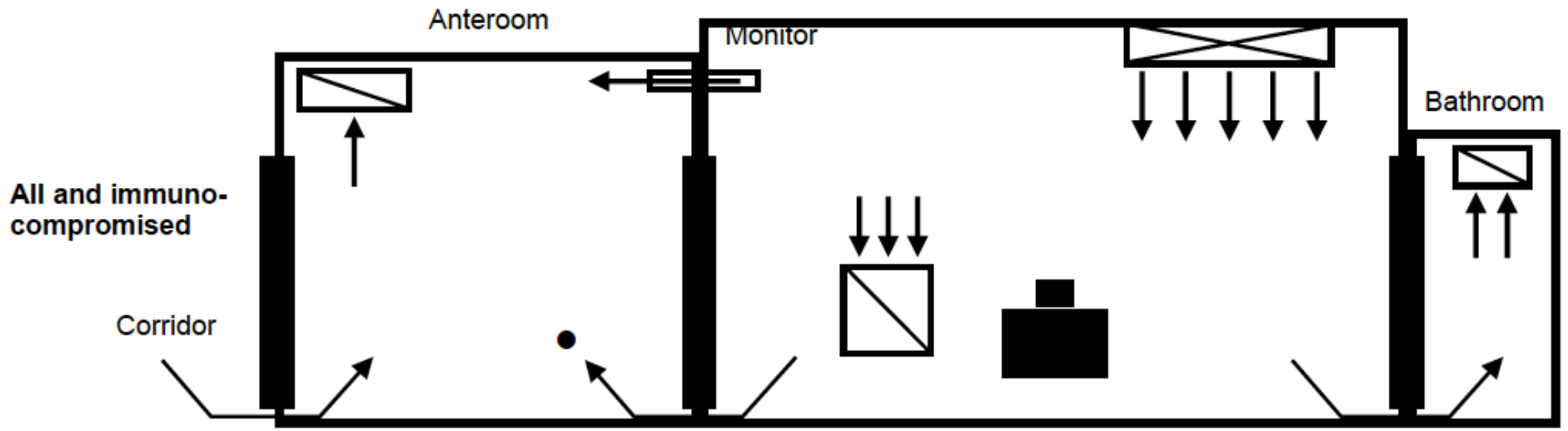
Isolation Facilities

- Classification
  - Standard pressure (Class S)
  - Negative pressure (Class N) – with anteroom (interlocking doors)
  - Positive pressure (Class P) – with anteroom (interlocking doors)
- Flexible and robust to accommodate new healthcare trends, technological advancements and changes in clinical practices
  - Space, layout, workflow
- Ensuite for each single bedded room and isolation room
  - Toilet, hand basin and shower
  - Grab rails and patient call system

Class N



Class P



Isolation facilities

- Cohort and single bed
- Recommended 14-20 unclassed beds in each ward
- Each bed has minimum clearance of 1200 mm from side of bed to wall or nearest fixed obstruction
- Minimum clearance of 1200 mm at foot end of each bed

Pandemic preparedness

- Scalability to ramp up when need arises
- Possibility of lock down for sections to quarantine areas (to prevent any spread)
- Enable effective contact tracing of staff entering/leaving affected ward or zone
- Hand cleaning facilities at door

Heating, ventilation, and air-conditioning systems including systems involving water supply and plumbing

Indoor air quality and ventilation is a critical factor in these high risk areas

- Intensive care facilities
- Isolation rooms / unit
- Operating theatres
- Endoscopy reprocessing areas
- Pharmacy laboratories
- Sterile supply unit (CSSD)

Time required for airborne contaminant removal at efficiencies of 99% and 99.9%

Air changes per hour (ACH) *	Time, T, required for removal, min†	
	99% efficiency	99.9% efficiency
2	138	207
4	69	104
6‡	46	69
8	35	52
10‡	28	41
12‡	23	35
15‡	18	28
20	14	21
50	6	8

Number, type and placement of hand-hygiene fixtures, clinical sinks, dispensers for soap, alcohol hand-rub, paper towels, and lotion

Hand hygiene

- Critical role in preventing transmission of pathogens causing healthcare associated infections
- Facilities for easy access
  - Hand basins
  - Alcohol-based hand rub agents
  - Hand moisturisers
- Single bedroom (including ICU)
  - Minimum of one clinical wash hand basin
  - Ensuite single bed-rooms should have a separate general wash hand basin for patients and visitors in the ensuite facility.
- Multi-bedrooms (including ICU)
  - Two clinical wash-hand basins should be provided
  - All ensuite facilities should have a wash-hand basin for use by patients and their visitors

Hand basins

- Clinical areas
  - Hand washing only
  - Taps should not be aligned to discharge directly into the waste aperture and the alignment of tap and basin should be such that staff can wash their hands without excessive splashing to their bodies
  - It should not have an overflow or be capable of taking a plug
  - Accessible and should not be situated behind curtain rails

- Non-clinical areas
  - Hand basins in non-clinical areas should permit routine hand washing and taps may be basin mounted and lever operated.

- All should be sealed to a waterproof splash-back and iequipped with liquid soap and paper towels dispenser

- Space should be allowed during planning stage for the placement of hands-free waste bins next to each wash-hand basin

Hand wash basins

- Area not less than 930 cm^2
- Minimum 250 mm width or length and depth
- Drainage not directly beneath faucet (splash)

Locations of sinks

- One at the entrance/ exit of the unit
- One in each patient bed room, located outside the bed screen and convenient to staff access
- One in each multi-bed (4, 5 or 6 bedded) patient room
- One located adjacent to staff station(s)
- At corridor bay(s), quantity of basins should be provided to suit the layout such that staff is not more than 10 metres from a basin
- Within water closets (WC) / toilet

Pseudomonas aeruginosa outbreak

- Outbreak at haematology wards from 15 November 2010 to 24 April 2011, involving 11 patients
- Contaminated sink drainage

Ling, Moi Lin and How, Kue Bien. *Pseudomonas aeruginosa* outbreak linked to sink drainage design [online].*Healthcare Infection* 18(4) 143-6

Ten clinical isolates (*Klebsiella pneumoniae* [n = 5], *Serratia marcescens* [n = 4] and *Enterobacter cloacae* [n = 1]) and one screening isolate (*Escherichia coli*) containing the bla_{IMP-4} gene detected over the 30-month period.

2 Existing design of intensive care unit sink compared with a design that complies with Australasian standards[8]

A: Existing sink, showing water spray directly over drain. **B:** Compliant sink design, showing larger basin and less forceful water flow directed away from drain, to prevent splash back and contamination with drain contents. ◆

Kotsanas D et al. MJA 2013; 198:267–269

Sink Design Features

Sink design features

Sinks in handwashing stations *shall* be designed with deep basins to prevent splashing; designed to prevent splashing to areas where direct patient care is provided, particularly those surfaces where sterile procedures are performed and medications are prepared.

The number and location of handwashing stations *shall* be determined by the functional program and the ICRA.

Handwashing stations *shall* be convenient and accessible for health care personnel and other users.

Sinks *shall* have well-fitted and sealed basins to prevent water leaks onto or into cabinetry and wall spaces.

Sensor-regulated water fixtures *shall* meet user need for temperature and length of time the water flows. Electronic faucets *shall* be capable of functioning during loss of normal power.

Hand towels shall be dispensed so that users need touch only the towels and not the dispenser.

Basin: porcelain, stainless steel, or solid surface materials. If the basins are set into plastic laminate countertops, at a minimum, the substrate *shall* be marine-grade plywood (or equivalent) with an impervious seal.

The water pressure at the fixture *shall* be regulated. (Pressure *should* be adjusted to reduce forceful discharge into the sink at maximum flow.)

Design of sinks *shall* not permit storagebeneath the sink basin.

Faucets *should* not discharge directly above the drain as this causes splashing (ie, water *should* be angled away from the drain).

Design of sinks *should* accommodate ADA requirements for clearance under the sink basin.

Sink size and depth: ANSI standards *should* be considered for sink design.

PPE and sharps disposal unit placement

Personal protective equipment (PPE)

- Refers to masks including N95/P2, disposable gloves, goggles or face shields, gowns
- PPE racks and mirrors should be installed along corridors for people to don and remove PPE before entering cubicles or rooms for patients placed on isolation precautions
  - Long mirrors help staffs to check that PPE is worn appropriately
- Consider area for wearing and removal

Surfaces: ceiling tiles, walls, counters, floor covering and furnishings

Finish

- Floor of the isolation rooms, including the anterooms should be monolithic, homogenous with a coved floor base and skirting that terminates above the floor finish level for ease of cleaning and prevents colonisation of micro organisms.
- Ceiling finishes should be monolithic, without crevices, impermeable and able to withstand hospital grade disinfectant.
- All surfaces in the isolation and anterooms should be able to withstand regular cleaning and decontamination.
- Removable ceiling tiles are not advised for special ventilated isolation rooms/ suites
- The floor, wall and ceiling of an isolation room should be solid, sealed and continuous.


© Tristan Titeux www.CustomCarpentry.co.uk

Design principles

- Design for easy cleaning
  - Finishes that are easy to clean
  - Flooring in clinical areas are seamless, smooth, slip-resistant, easily cleaned and water-resistant
  - Concealed supply pipework

Balancing use of materials – efficient and easy to clean

- Facilitate cleanliness and cleaning
  - Impervious, smooth, seamless finishes
  - Run hard flooring up to walls (easy-to-clean cove)
  - Eliminated dead-legs and blind ends in water system
  - Hands-free operation of utilities
  - Integral blinds as alternative to curtains at windows

Utility rooms: soiled, clean, holding, workrooms

- Clean and dirty areas should be kept separate and the workflow patterns of each area should be clearly defined.

- The design and finish of ancillary areas should facilitate good cleaning. They should have facilities for hand-hygiene and sufficient storage for supplies and equipment

ICU toilet rooms

- FGI guidelines 2012
- Each ICU room must now have direct access to an enclosed toilet room or a soiled utility room with a clinical (flushing rim) sink for disposal of bodily waste
  - at minimum, a toilet room and toilet equipped with a bedpan washer or a soiled utility room with a flushing clinical sink between every 2 ICU rooms

Clinical waste; linen (clean)/laundry (used)

Environmental risks to infection

- Legionella control
  - Hot water storage tanks, shower head, cooling towers, etc
- Design and finish of areas should facilitate good cleaning
- Immune-compromised patient facilities
  - Avoid creating reservoirs e.g. carpets, ice making machines, water fountains, aquariums, etc.

Waste management

- Medical and biological wastes should be segregated from municipal solid waste
- A separate waste collection, management and disposal system should be provided for medical and biological wastes
- Waste management system shall comply with the Environmental Protection and Management Act and its Regulations

Storage: movable and modular equipment, and storage for sterile medical devices

Issues to look out for….

- Design and planning phase
  - Hazards associated with infection risk should be identified and assessed, and measures taken to manage these risks
  - ‘Design in’ measures which will eliminate or minimise the impact of identified hazards and effectively manage the risk of infection

Overall layout

- Space planning
- Elevators and workflow
  - Providing a logical progression and flow between different spaces
- Drawings
  - 1:200 sketch design and 1:50 scale detail design stages of the project
  - HVAC plans
- Mock-ups helpful

Design for optimal and safe flow

- Logical progression between clean and dirty areas
- In pandemic, modular shut down to isolate areas
- Plan for separate clean and dirty flows for waste including linen.

Design and structure issues

- Design, number and type of isolation rooms
- HVAC
- Mechanical systems involving water supply and plumbing
- Number, type and placement of hand hygiene fixtures, clinical sinks, dispensers for soap, alcohol hand-rub, paper towels and lotion

Design and structure issues

- Sharps disposal unit placement
- Accommodation for PPE
- Surfaces – ceilings, tiles, walls, counters, floor covering and furnishings
- Utility rooms – soiled, clean, holding, workrooms
- Clinical waste
- Linen / laundry
- Storage of used and sterile medical devices

Patient rooms

- US, Europe, UK, Canada – single rooms for new acute care facility
  - UK – 50% single rooms for non-acute care facility
- Ireland – not more than 3 beds per cubicle!
- En-suite toilet

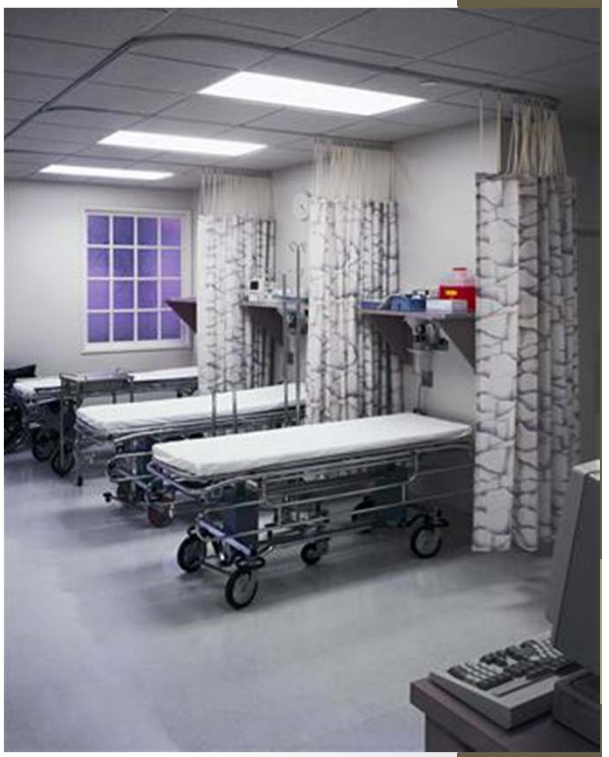
Bed space and layout

- Single patient bedroom(s) should have adequate space to fit equipment, allow movement of medical staff and visitors
  - Minimum clearance of 1200 mm from the side of bed to the wall or the nearest fixed obstruction
  - Minimum clearance of 1200 mm available at the foot end of each bed

- Multiple patient bedroom(s)
  - Minimum clearance of 1500 mm between side edges of bed to another bed, and another minimum 1000 mm clearance available at the foot end of each bed, to allow for easy movement of equipment and beds
  - Adequate clearance between the head of bed and the wall or fixed obstruction is required for resuscitation

Sizing and layout

- Principle - maintain sufficient space for activities to take place and to avoid cross-contamination between adjacent bed spaces



Community Hospital

- Model of care
  - Subacute care or rehabilitation?
- Subacute care
  - Refer to acute care standards
- Isolation room requirements
  - Community hospital – 15% of beds
    - 1 AII room per 200 beds

Residential Health (Nursing Homes)

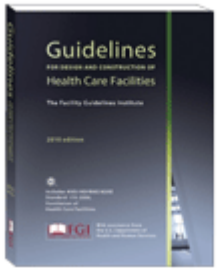
- Residential care
  - Aged
  - Chronic sick
  - Dementia

- Isolation facilities
  - 10% of beds (single and cohort)

Commissioning

- Site visits
- Compliance to specifications
  - Design and layout
  - Furnishings and fittings
  - Decorations, artwork
  - Ventilation specifications
    - Smoke test, microbiological sampling
- Storage and subsequent cleaning/disinfection of any furniture or equipment

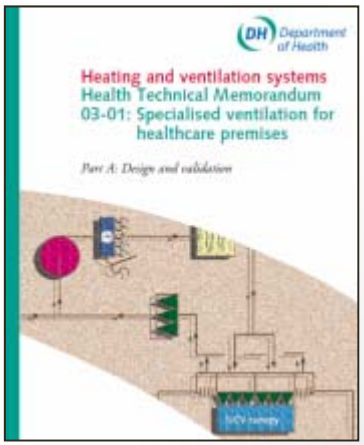
Good references



- FGI (Facilities Guidelines Institute) Guidelines (USA)

- ASHRAE (The American Society of Heating Refrigerating and Air Conditioning Engineers) Standards (USA)

- HTM 03-01 Specialised ventilation for Healthcare premises (by DHS, UK)



References

- Technical reference
  - Facility Design Guidelines for Acute General Hospitals (2015)

- Prepared by Working Group appointed by Technical Committee on Architectural Works under direction of Building and Construction Standards Committee (BCSC)

THANK YOU